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KOKAI PATENT APPLICATION NO. SHO 63[1988]-168626

Technical Indication Section	
Int. Cl.[4]:	G 02 F 1/133 G 09 F 9/00
Identification code:	311 322
Sequence Nos. for Office Use:	7370-2H A-6866-5C
Application No.:	Sho 62[1987]-874
Application Date:	January 6, 1987
Publication Date:	July 12, 1988
No. of Inventions:	1 (Total of 4 pages)
Examination Request:	Not requested

LIQUID CRYSTAL DISPLAY

[Ekishohyojitai]

Applicant:	Citizen Watch Inc. 2-1-1 Nishishinjuku Shinjuku-ku, Tokyo

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840 Takeno Aza, Shimotomi
Oaza, Tokorozawa-shi
Saitama-ken

[*There are no amendments to this patent.*]

Specification

1. Title of the invention

Liquid crystal display

2. Claims of the invention

(1) A liquid crystal display wherein linearly-polarized light is applied to a liquid crystal panel and a display is produced by electrically controlling the direction of orientation of the liquid crystal molecules, a grid polarizer that polarizes light entering the system into two orthogonally polarized components and an element that rotates the plane of polarization of one component of the entering light flux by 90° is used as an element for producing the above-mentioned linearly-polarized light; the above-mentioned polarized components are transmitted to a liquid crystal panel and used for illumination of the image plane.

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Furthermore, transparent electrodes 5 and 6 that actuate the liquid crystal are formed on the two glass sheets 3 and 4.

In the past, a PVA (polyvinyl alcohol) film uniaxially drawn to 3 to 4 times and with iodine molecules or dichroic molecules adsorbed on it has been used for the polarizer. In this manner, the polarized component parallel to the major axis of the molecule is absorbed, and light that enters is converted to the required linearly-polarized light.

[p. 2]

[Problems to be solved by the invention]

However, in order to obtain linearly-polarized light, the vertically-polarizing component is absorbed, and, as a result, the efficiency of utilization of the unpolarized light that enters is 50% or less, and, in reality, it is 40% or less, and the loss is high. As a result, the brightness at the image plane is reduced, and to compensate for the loss, backlighting is required; thus, an increase in power consumption and reduced battery life in liquid crystal television sets and monitors results.

Based on the above background, the objective of the present invention is to provide a structure consisting of an optical system capable of reducing the light loss in a polarizer and to increase the brightness of the image plane so that it is possible to reduce power consumption.

(2) The liquid crystal display specified in claim 1 above wherein a combination of a quarter-wave plate and a reflector plate is used as the element that rotates the plane of polarization by 90°.

(3) The liquid crystal display specified in claim 1 above wherein a diffusion plate is used as the element that rotates the plane of polarization by 90°.

3. Detailed explanation of the invention

[Field of industrial application]

The present invention pertains to the structure of an optical system of a liquid crystal display.

[Prior art]

The optical system of a conventional liquid crystal display is explained with reference to the figures. Fig. 4 is the cross section that shows the optical system of monochromatic liquid crystal display. In the figure, the arrows and the black dots indicate the direction of polarization. First, light that enters the liquid crystal display is diffused by diffusion plate 1, and converted to linearly-polarized light by polarizer 2. The linearly-polarized light is transmitted to liquid crystal panel 8, the plane of polarization is rotated by the picture element and is transmitted by analyzer 9 to achieve display. In liquid crystal panel 8, a liquid crystal fills the gap between two glass sheets 3 and 4 separated by spacer 7.

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Natural light applied from light source 11 is transmitted by diffusion plate 1 and enters polarizer 2. The polarized component that is perpendicular to the metal lattice is transmitted, and the remaining polarizing component is reflected. The reflected light is transmitted by quarter-wave plate 10 and becomes circularly polarized and is reflected by mirror 12 and transmitted by quarter-wave plate 10 for a second time to be converted to linearly-polarized light.

However, in this case, the plane of polarization is rotated 90° with respect to the light that originally entered the quarter-wave plate, and is transmitted by polarizer 2. Thus, the plane of polarization of the two polarized components that were originally orthogonal become parallel and both are used to light liquid crystal panel 8. Subsequently, the direction of the polarization of the light is modulated by liquid crystal panel 8, and applied to analyzer 9, the direction of polarization is matched to the brightness and display is achieved. In liquid crystal panel 8, the liquid crystal is sealed between two glass sheets 3 and 4 having transparent electrodes 5 and 6 separated by spacer 7.

However, in this case, the system that rotates the plane of polarization by 90° through the combination of quarter-wave plate 10 and mirror 12 is for specific wavelength; thus, the intensity of light that enters the liquid crystal panel 8 is a distribution with the specific wavelength as a maximum; thus, the above-mentioned point should be taken into consideration in color displays. In other words, in order to produce an adequate color display, adjustments are made for the distribution of transmissivity of the wavelength of the color filter or for the distribution of radiant intensity for the wavelengths of the light source.

[Means to solve problems]

In the present invention, the polarized component that is absorbed in conventional polarizers is utilized, and the efficiency of light utilization in the polarizer is increased so as to increase the brightness of the image plane. In order to achieve the above-mentioned objective, a grid polarizer is utilized. The grid polarizer separates the light entering the system into transmitted light and reflected light via two orthogonal polarizing components. The transmitted light enters the liquid crystal panel directly, and the reflected light is reflected by a mirror having a quarter-wave plate on the front surface and the plane of polarization is rotated 90°, and the reflected light is transmitted by the polarizer and enters the liquid crystal panel.

Furthermore, as a means to utilize the reflected light, instead of the quarter-wave plate, a method wherein a diffusion plate is utilized to produce a random direction of polarization of the reflected light and the polarized component is transmitted can be used.

[Application example]

In the following, an application example of the present invention is explained with drawings.

Fig. 1 is a cross section that shows the liquid crystal display of the first application example of the present invention. In the figure, polarizer 2 is a grid polarizer. The polarizer has a very fine lattice structure achieved by arranging metals in parallel. When a wavelength two times the lattice distance enters, the polarized component parallel to the lattice is reflected and the polarized component perpendicular to the lattice is transmitted.

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Natural light applied from light source 11 is transmitted by diffusion plate 1 and enters polarizer 2. The polarized component that is perpendicular to the metal lattice is transmitted, and the remaining polarizing component is reflected. The reflected light is transmitted by quarter-wave plate 10 and becomes circularly polarized and is reflected by mirror 12 and transmitted by quarter-wave plate 10 for a second time to be converted to linearly-polarized light.

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However, in this case, the system that rotates the plane of polarization by 90° through the combination of quarter-wave plate 10 and mirror 12 is for specific wavelength; thus, the intensity of light that enters the liquid crystal panel 8 is a distribution with the specific wavelength as a maximum; thus, the above-mentioned point should be taken into consideration in color displays. In other words, in order to produce an adequate color display, adjustments are made for the distribution of transmissivity of the wavelength of the color filter or for the distribution of radiant intensity for the wavelengths of the light source.

[Effect of the invention]

[p. 3]

As described above, according to the present invention, it is possible to utilize the polarized component previously absorbed and polarizer loss can be reduced. As a result, the power consumption required for backlighting to achieve an image with the same brightness by the conventional method can be reduced to approximately one-half.

Furthermore, for the same power consumption, an image with increased brightness can be achieved.

4. Brief description of the figures

Fig. 1 is a cross section of the optical system of the liquid crystal display that shows an application example of the present invention, Fig. 2 and Fig. 3 are cross sections of optical systems of liquid crystal displays for different application examples of the present invention, and Fig. 4 is a cross section of the optical system of a conventional liquid crystal display.

As a similar application example, the optical system of a liquid crystal display with the structure shown in Fig. 2 is conceivable. In this case, instead of the quarter-wave plate 10 shown in Fig. 1, a diffusion plate 1 between light source 11 and polarizer 2 is utilized as the element for rotation of the plane of polarization.

In other words, light transmission by diffusion plate 1 is sacrificed somewhat, and the plane of polarization of the linearly-polarized light is random. Then, the light flux that passes through diffusion plate 1 is reflected by mirror 12, and applied to polarizer 2, and is utilized to increase the brightness of the image plane.

Fig. 3 is a cross section that shows the optical system of a liquid crystal display of a different application example, and is an example of a structure wherein an external light source is utilized. Microlens array 13 is installed and pin hole plate 14 is aligned at the focal plane. External light is focused by microlens array 13 on pinhole plate 14 at the focal and is transmitted to polarizer 2.

Furthermore, the reflected light from polarizer 2 is reflected by pinhole plate 14 which has an aluminum , etc. deposition on the backside to provide a mirror surface. The reflected light is converted to natural light by diffusion plate 1; thus, it can be reapplied to optical system 2 and utilized.

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Fig. 3 is a cross section that shows the optical system of a liquid crystal display of a different application example, and is an example of a structure wherein an external light source is utilized. Microlens array 13 is installed and pin hole plate 14 is aligned at the focal plane. External light is focused by microlens array 13 on pinhole plate 14 at the focal and is transmitted to polarizer 2.

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[Effect of the invention]

[p. 3]

As described above, according to the present invention, it is possible to utilize the polarized component previously absorbed and polarizer loss can be reduced. As a result, the power consumption required for backlighting to achieve an image with the same brightness by the conventional method can be reduced to approximately one-half.

Furthermore, for the same power consumption, an image with increased brightness can be achieved.

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1...Diffusion plate
2...Polarizer
3, 4...Glass sheets
5, 6... Transparent electrodes
7...Spacer
8...Liquid crystal panel
9...Analyzer
10...Quarter-wave plate
11...Light source
12...Mirror
13...Microlens array
14...Pinhole plate

Fig. 1

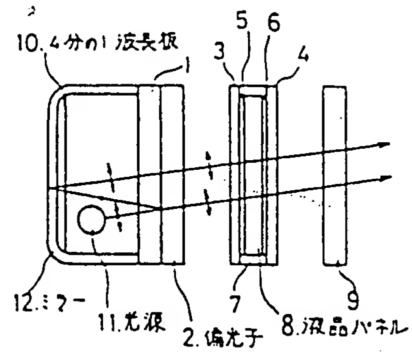


Fig. 2

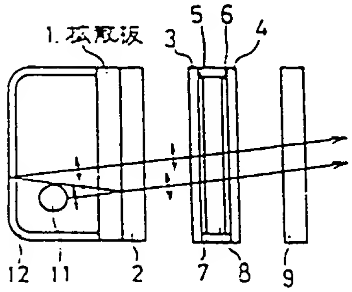


Fig. 3

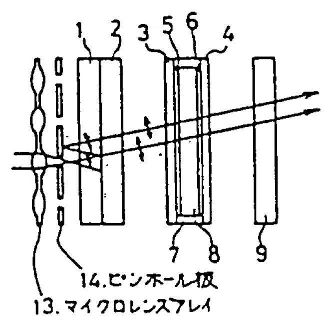
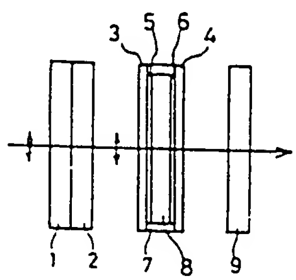


Fig. 4



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13...Microlens array
14...Pinhole plate

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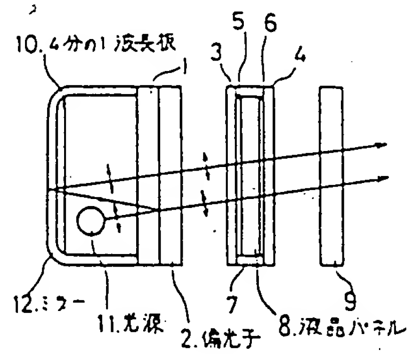

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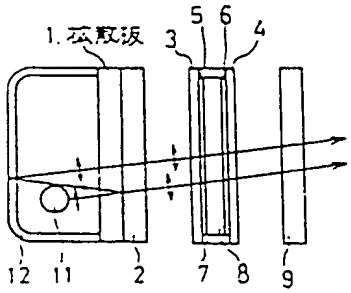

Fig. 3

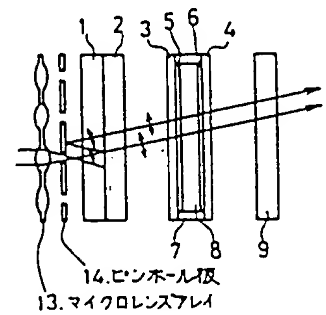

Fig. 4